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# DIGITAL COMPUTER NEWSLETTER

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## **Editorial Policy Notices**

### **EDITORIAL**

Although the Digital Computer Newsletter is a Department of the Navy publication, it is not restricted to the publication of Navy-originated material.

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### **CONTRIBUTIONS**

The Office of Naval Research welcomes contributions to the Newsletter from any source. It is through these contributions that the value of the Newsletter is enhanced as a medium of exchange between government laboratories, academic institutions, and industry.

A limitation on size prevents the publishing of all material received. Contributed items which are not published are kept on file and are made available to interested personnel within the government.

It is regretted that because of limited time and personnel it is often impossible for the editor to acknowledge individually all material received. It is hoped, however, that the readers will continue to submit technical material and suggestions to the editor for future issues.

Material for specific issues must be received by the editor at least three months in advance of the month of issue.

### **CIRCULATION**

The Newsletter is published quarterly (January, April, July, and October) and is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

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Washington, D. C. 20380**

## Computers and Data Processors, North America

### L-304F Microelectronic Computer

*Litton Industries  
Beverly Hills, California 90213*

**Litton Industries' new L-304F microelectronic general-purpose computer will greatly increase the effectiveness of the Navy in meeting rapidly changing tactical situations throughout the world.**

The new computer, which will perform more combat-related functions than the special-purpose unit it replaces, was chosen by Grumman Aircraft Engineering Corp. for its AX modification program of the E-2A Hawkeye aircraft.

Data Systems Division of Litton is building an undisclosed number of L-304F computers and will modify the systems display units and power assemblies for Grumman under a \$46 million production contract, according to Fred W. O'Green, Litton executive vice president and head of the Defense and Space Systems Group. The first production L-304F is scheduled for delivery to Grumman in November 1968.

"The L-304F is the first microelectronic general-purpose computer of its type to be incorporated into an aircraft by the Navy," Mr. O'Green noted. "It offers much higher reliability through extensive use of integrated circuits, with the concomitant advantage of simplified maintenance. Both are of vital importance in a combat situation."

To be installed in the carrier-based Hawkeye, now operating in Southeast Asia, the new Litton computer will function in the Airborne Tactical Data System (ATDS) command and control system.

The L-304F computer may be reprogrammed quickly under combat conditions to achieve different mission objectives, while the special-purpose unit requires actual changes in hardware.

Operational programs can be completely altered simply by loading prepared tapes into the computer memory. As tactical situations

change, the Navy can readily adapt its computer programs to meet the requirements. In addition, the L-304F computer will be able to accommodate an expansion of total operating programs of at least 50 percent over the existing equipment.

The L-304F has a command and control capability of up to 64 program levels, with each level having its own separate program operating on a time-shared basis, C. Gordon Murphy, vice president of Litton and president of Data Systems Division, said in describing the computer design. In addition, should the power fail, the computer's memory retains all stored data. The multi-processor arrangement assures continued operation should a processor, memory module, or peripheral unit fail. The present special-purpose unit contains a 23,000-word drum memory, and the L-304F programmable computer contains 56,000-word core memories that can be expanded to 80,000 words by adding modules.

Additionally, the L-304F will permit interchange of communications and fast data computations with the Marine Corps Tactical Data System (MTDS), effectively providing the commander with a unified control system to meet tactical situations. The MTDS is a highly automated system for controlling air weapons and managing air space.

Specific ATDS operations possible with the microelectronic L-304F are: target detection and acquisition, tracking and identification, threat evaluation, weapon assignment, and interceptor control. It also directs air search and rescue operations. The system consists of search radar, computer, memory, and data link, which are coordinated with the overall shipboard-based Naval Tactical Data System (NTDS). The E-2A, the airborne electronic eyes and ears of the NTDS, provides an advanced early warning detection network for task forces, relaying information for rapid fleet tactical decisions.

## Computing Centers

### GE 625 System Performance

*Kiewit Computation Center  
Dartmouth College  
Hanover, N.H.*

A significant milestone was reached in January at the Kiewit Computation Center on the Dartmouth College campus. More than 100 persons successfully use a General Electric 625 computer simultaneously.

This is believed to be a world's record for time-sharing computers, Dartmouth College and GE, the number of simultaneous users exceeded 100 for a period of nearly an hour. Most requests receive responses within 10 seconds, and the peak load of 113 was reached at 2:30 p.m. on Thursday, Jan. 18.

John G. Kemeny, Dartmouth mathematics professor and a pioneer in time-sharing development, described the event as "a major breakthrough which opens up an exciting future for the educational use of computers."

He said that this accomplishment "gave dramatic testimony to the mutually beneficial results which can be achieved through cooperation between a major industry and an educational institution."

At the peak time, the computer system was serving 47 Dartmouth faculty members and students, 20 students from secondary schools in the northern New England region and 46 customers of the General Electric Information Service Department located in the Boston, New York, and Washington, D. C., areas.

The computer is connected by ordinary phone lines with GE computer terminals in the various remote locations.

Each user was able to type a set of instructions known as a program into his individual terminal (a teletypewriter) and have his request for data processing serviced almost instantly by the GE-625 computer on the Dartmouth campus.

Because of the giant computer's high speed, each remote user in effect has his own personal "desk-side" computer at his command day and night.

## Computers and Centers, Overseas

### Control Data 6600

*University of London  
London, England*

The University of London in London, England has ordered a Control Data 6600 Computer System. Scheduled for delivery late in 1968, the multi-million dollar computer was ordered with the approval of the University's Computer Board. It will provide the University of London with the largest and most powerful data processing system in England.

The new 6600 will furnish a central computer service to all areas of the University for use in research and teaching. It will be housed in a new building now under construction in the Central London Area. The computer's 131,000-

word (60-bit) core memory will be supplemented by CDC magnetic disk files and tape transports. High-speed line printers, and punched card and paper tape equipment will also be included in the system.

Initially, two Satellite computers, small-scale Control Data 1700's, will communicate with the 6600 over special data links. One 1700 will be installed at Imperial College. The other will serve Kings College and the London School of Economics. Four data links between the 6600 and computers at other colleges are planned.

### Southampton University On-Line Computer

*The Marconi Company Limited  
Chelmsford, Essex, England*

In an application believed to be unique in Europe, Southampton University has installed a Marconi computer to accept and process experimental results as they occur. The machine, a Marconi Myriad II, has slashed to a hundredth, the time taken to analyse sound and vibration measurements. It will speed research and development work in many fields, involving, for example, motor vehicles and aircraft, including parts of the Concorde supersonic airliner.

The Institute of Sound and Vibration Research at the University has set up a Data Analysis Centre, based on this computer, and laboratories have been connected to the system through coaxial cables. Electrical signals, exactly like those produced by a record player pick-up, but taken from microphones and other types of vibration transducer, can be fed to the computer for rapid analysis, with results plotted in graphical form. Before they can be "digested" by the computer, these signals are sampled 40,000 times per second and converted into binary code, using new analogue to digital converters. This equipment and the Marconi computer, which is one of the fastest in the world, ensures precise statistical accuracy. Facilities have been arranged at the Centre for feeding the system with signals from tape recordings if "on-line" use is not required.

Dr. Colin Mercer, Lecturer in Structural Vibrations is in overall control of the scheme and he is in the process of making some of the computer time available to outside organisations, particularly car and aircraft manufacturers. He says, "A large number of people, firms, and research organisations have a major problem on their hands in analysing sound and vibration information. It is easy enough taking the measurements, using microphones and transducers—and you can tape record the electrical signals quite easily. From there, however, analysing the results takes a long time and requires painstaking concentration. To a firm, this is money and scientists' time being drained away. I have known of some organisations with cupboards full of tape recordings waiting for analysis."

Roger Pacifico, Centre Manager, and Dr. Mercer now believe they have found a complete solution for this problem. The computer is currently being programmed to allow it to be operated by research personnel who are completely inexperienced in programming techniques. The computer will ask a set of questions via a teletypewriter, and these can be replied to with ordinary written answers. The type of analysis is ascertained, together with the sampling period and other necessary infor-

mation. After this, at the push of a button, the analogue signals are fed directly into the machine.

Cross-correlation of two separate signals is a typical requirement. For example, by placing two sensing devices at different points in a ventilation system, much can be learnt about the way in which certain sound components are absorbed or generated. Accurate information on common features of each waveform can be produced in graphical form or on paper tape by the computer, which accepts, simultaneously, two inputs through separate ana-

logue to digital conversion systems. Many other analysis techniques can also be carried out; in the near future, several more analogue inputs will be available.

Dr. Mercer is very satisfied that he has found the right computer for this purpose, and says, "having studied all practical alternatives, we found that the organisation of the Myriad II machine is ideal for dealing with the high data speed. I believe that there are at least half a dozen other places in the country where a similar set up is needed and where a capital outlay of some £50,000 would bring substantial savings."

#### I.C.T. 1907

*Queen's University  
Belfast, Ireland*

The I.C.T. 1907 computer which was installed in January 1968 at Queen's University at Belfast, is being used to help implement a computer system of storing students records for those attending the university.

This 1907 installation, which is the second one installed for a customer (the first was Southampton University) is being used to store complete academic and personal records of each student at Queen's University. By-products of this system are an archives system for ex-students and an examination sub-system whereby an examination programme is prepared for each student, giving the examination date, time, and seat number. After the examination papers have been checked in the usual way, the computer is used to produce a print-out of the results which can be extended to inform each student at his home address of his success or failure.

Queen's University is 1 of about 10 universities throughout Britain, all of which are represented by a Working Group that has been set up solely to provide a common system of storing student records throughout the universities. This common system has been based on the I.C.T. 1900 Series computers. Wallace Ewart, Chairman of the Working Group is the Head of

the Queen's University Data Processing Department. Three universities have already implemented complete programs on their 1900 Series computers: Queen's in Belfast and Southampton on their 1907's, and Essex University on its 1909 installation.

It is envisaged that in about 3 years the computer will be contributing to the selection of university entrants, based on the analysis of GCE results and on the headmaster's reports.

Multi-access computing facilities to enable research workers to have the use of the computer from their laboratories are being developed. Seven on-line typewriters are being installed for this purpose around the University.

The installation consists of an I.C.T. 1907 Central Processor, with 64 K core store, 6 magnetic tapes, 2 exchangeable disc transports, a 900-cpm card reader, a 100-cpm card punch, a 1000-cps paper tape reader, a 110-cps paper tape punch, a 1350-line per min line-printer, and a graph plotter. Seven remote typewriter terminals will soon be in operation; a two million character drum is due in April 1968; and a visual display unit is to be added in the near future.

#### I.C.T. 1907

*Southampton University  
Southampton, England*

The first I.C.T. 1907 computer system to be delivered to a customer, is now fully operational at Southampton University. It is the second 1907 in operation; the first one was put into operation at I.C.T. offices in Putney in August 1967.

Taking over from an interim I.C.T. 1909 installation at the University, the £314,000 1907 installation is already handling a wide variety of tasks involving both University studies and general University organisation.

The I.C.T. 1907 is being used for a variety of interesting research projects, including: the examination of natural languages for pattern recognition; the analysis of data collected from the United Kingdom satellite whilst in orbit; the classification of rock specimens using an x-ray spectrometer producing punched tape (this will later be connected directly to a remote terminal); and aircraft vibration analysis for sections of Concord.

#### LIBRARY APPLICATIONS

Among the general University organisation projects, being run on the 1907, one of the more unusual applications is that of keeping a comprehensive log of library issues.

Instead of adopting the normal practice of storing references to all library publications in the computer together with a student/book allocation, only records of those books out on loan need be held in store. Southampton developed the special coding scheme that enabled this more economical procedure to be implemented.

Every student at the University is given an identity badge containing punched holes corresponding to his code number in the student records. In the back of each library book is a

punched card referring to that book's code. When a student wishes to take out a library book, both his identity badge and the book's punched card are inserted into a Friden Collectadata reading device, which produces punched tape containing all the necessary data identifying the book and the student who is borrowing it. The same procedure is used to record the return of books. Each day the punched tape is used to update the library records stored on the 1907. Thus up-to-date records are kept of issues, returns, reservations, and renewals.

From the store, all library records and reader analyses can be obtained together with answers to requests about who is holding a particular book. The Collectadata machine which is situated in the University library will later be directly connected on-line to the 1907.

The I.C.T. 1907 comprises a central processor with a 32 K, 2-microsecond core store, a 300 c/m card reader, two 300 ch/sec paper tape readers, a 1350 line/minute printer, six 20-kc magnetic tape units on one control, and three 4 million character exchangeable disk stores. In addition there is a multiplexer with 15 remote terminals which are being located in various departments throughout the University.

## Miscellaneous

### Remote Computing Usage

Battelle Memorial Institute  
Columbus, Ohio 43201

The College of Wooster (Ohio) and Battelle Memorial Institute will cooperate in a pilot program to determine to what extent a college can rely upon a remote computer to fill its research, teaching, and administrative needs.

Under the terms of an agreement between the two institutions, Wooster will have leased telephone line access to a Control Data 6400 computer at Battelle's Columbus Laboratories some 80 air miles southwest of the campus. In addition, there are provisions for an exchange of personnel between the campus and the research center for programming and instruction purposes.

Earlier this year Dr. J. Garber Drushal, Acting President of the College of Wooster, made an announcement of the plans (then pending) to the Wooster Board of Trustees. He pointed to the urgent need to make available sophisticated and versatile computer services to students, faculty researchers, and administrators; and he stressed that this should be done without the need of major capital investments for the small liberal arts colleges. The College Trustees voted unanimous approval of the direction in which the college's administrators are moving.

Commenting on the agreement, Wooster Vice-President, Dr. Hans H. Jenny, said that on a relatively modest cost-incurred basis the 1500-student college will have use of the largest and fastest computer in Ohio, and one of the most advanced machines in the world. In addition, the college will be able to call upon the expertise of some 20 Battelle-Columbus computer specialists, having an average of 7 years professional experience.

Michael Tikson, in charge of computation research at Battelle-Columbus, praised Wooster for its pioneering initiative in computer education, indicating the agreement with Wooster could well point the way to needed widespread on-campus computer education at a reasonable cost. This cooperative program, he observed, represents one attempt to answer the needs of

colleges identified in a recent report prepared by a special White House advisory panel convened to study computer education at the college level.

The Panel report stated that "In the field of scholarship and education, there is hardly an area that is not now using digital computing.... Computing increases the quality and scope of education." Panelists expressed the belief that "the best and most efficient computing is most likely to be obtained from large computing centers with the most modern equipment." Further, said the panelists "It is highly desirable to provide service to colleges and secondary schools which may be tens or even hundreds of miles from the central computer."

Tikson indicated that Battelle-Columbus has held discussions with other colleges that are also exploring means for obtaining computer services. This, he said, could lead to a large cooperative effort involving Battelle and a group of colleges.

To implement the agreement between Wooster and Battelle, the college is installing data transmission equipment and the research center is planning the addition of a multiplexer unit to channel incoming data into the computer. The Battelle computer center represents an investment of over \$2,000,000, and, plans call for \$1,000,000 worth of additional equipment to be installed over the next year.

The CDC 6400 system at Battelle-Columbus is capable of executing approximately 1,000,000 operations per second and can work simultaneously on several problems. It has a 65,536 word memory, each word made up of 60 bits. The associated peripheral equipment includes a 75-million-character disk file for storing programs read from punched cards, no 1200-card-per-minute readers, six IBM compatible tape units, two 1000-line-per-minute printers, one 500-line-per-minute printer, an on-line point plotter for graphic outputs, a paper-tape reader punch, and two 250-card-per-minute punches.

## Computerized Library Loan System

Bell Telephone Laboratories  
Murray Hill, New Jersey 07971

A computer-aided library loan system that gives instant circulation information to librarians who are miles apart has been demonstrated at Bell Telephone Laboratories. Called BELLREL (Bell Laboratories Library Real-time Loan), the system permits more efficient pooling of book collections and provides borrowers with a faster, more responsive loan service.

The system, which will begin operation this month, links via telephone lines the BTL Technical Information Libraries at Murray Hill, Holmdel, and Whippny, New Jersey, with a central store of information in a computer at Murray Hill. The system facilitates the loan of library materials to any person from any library in the New Jersey network.

For librarians, the BELLREL System offers "real-time" (immediate response) handling of information for loans, returns, renewals, reservations, and queries. For example, the circulation librarian can quickly determine the books already on loan to individuals, or the place of a person on a waiting list. In all, 18 types of "real-time" questions or transactions can be handled.

Overnight processing on a "batch" basis is used for ready-to-mail overdue notices, printed with all information including the borrower's address. This eliminates hand processing of some 60,000 notices per year. Batch processing also provides a number of records to aid library workers in determining the current status of books, journals, and other publications.

Book and borrower data required for immediate information retrieval is maintained in direct-access disk files. Also, a complete history of all transactions is recorded on magnetic tapes. These provide library supervisors with statistics and other information necessary for analyzing the flow of library materials and the patterns of borrower demand. The frequency of requests for a book help determine whether it should be discarded or whether additional copies should be purchased.

Another feature of the system is the automatic chargeout of any returned item to the next borrower on the waiting list. When a book is returned, the computer sends a message to the librarian, instructing her where next to mail the book.

In a demonstration, a loan clerk at the keyboard of an input terminal at Holmdel queried

the computer at Murray Hill about the availability of book titles, and made additions to the waiting lists. In less than two seconds, she received a response from the computer. The answer was printed out at her typewriter terminal.

Because information can be recorded either directly through the typewriter console or through the use of a card reading unit at the input terminal, the system can handle all classes of library publications with or without the use of pre-punched book cards. This flexibility also is available for recording borrower identification, since two-thirds of the BTL library transactions are the remote kind, in response to telephone or mailed requests.

Bell Telephone Laboratories has one of the largest technical library systems in private industry with more than 100,000 bound volumes and subscriptions to thousands of periodicals.

In the BELLREL System each library initially will have two input terminals (IBM 1050 Data Communications Systems). Each input terminal includes a control unit and a card reading unit for reading punched book cards. Each terminal also includes a keyboard, similar to that of a typewriter in appearance, for initiating questions, recording transactions, and automatically printing out answers from the computer.

Messages from each input terminal are converted by a Western Electric 103A Data Set to pulses that can be transmitted over a telephone line. At the other end of the line at the Murray Hill computer center, a companion Data Set receives the message, which is then converted to computer-compatible language through a IBM 2702 Transmission Control Unit. An IBM 360-40 then processes and records the transaction. Almost simultaneously the computer's response is transmitted back to the original input terminal. The system was devised jointly by the library and the Comptroller's Division of Bell Laboratories. The programs, written by members of the Comptroller's Division, are 32 "real-time" and 23 "batch" programs, consisting of approximately 10,000 computer statements. The BELLREL System utilizes computer-managing software, called Operating System/360, supplied by the manufacturer. The program languages used are Common Business Oriented Language (COBOL) level F, and Basis Assembly Language (BAL).

## New Computerized Bank Accounting

Beverly Bank  
Chicago, Illinois 60615

With a small plastic card, a Touch-Tone telephone, and a computer with a "voice," a fast-growing bank on Chicago's south side has unlocked a new era in electronic banking for Illinois.

The 45-year-old Beverly Bank, at 1357 West 103rd Street, has now implemented the largest Touch-Tone card dialer/computer system in the banking industry and the first such system installed by Illinois Bell Telephone in any bank, according to Thomas V. Markle, the bank's president.

The system directly links some 140 Touch-Tone card dialer telephones in the Beverly Bank and its three client banks with an IBM 7770 audio response unit and an IBM/360 Model 40.

"The system is purely customer-oriented," Mr. Markle said. "To put its advantages in a nut shell, it reduces delay. It gives our staff more complete information about our customers' checking, savings and loan accounts, and does so twice as fast as was formerly possible."

"Also, since we're telephoning directly into the computer to get our information, we eliminate countless pounds of reports that the computer used to print each day--a tiny step toward reducing the billions of documents hampering today's businessmen. I guess you might say we're bringing the 'paperless society' a bit closer."

Mr. Markle said a customer cashing a large check or making a specific inquiry about his account need no longer wait while the teller manually checks his records.

"Rather," he continued, "with the use of pre-punched plastic cards—one for the teller and one for the customer—the teller calls the computer on the card dialer telephone, taps out the amount of the check on the Touch-Tone keyboard and gets a verbal answer to his inquiry in a matter of seconds."

Markle said that the acronym for this new electronic program is "BASIS," for "Bank Automated Service Information System."

Will Cooper, vice president and controller of the 104-million-dollar bank, added that an equally significant part of BASIS is the development of the "financial profile" statement which recaps a customer's total business with the bank.

The profile is possible through integrated computer files, which record each customer's diverse banking transactions under one major account number regardless of how many accounts are involved. Two-digit suffixes added to the major number identify specific accounts.

"We believe we are the first to provide this total service approach. On a customer's monthly statement, we not only will show the status of all bank business, but also itemize his checks by consecutive number to simplify balancing his statement."

"We're also the first to have all customer records stored 'on-line,' or directly available to authorized bank tellers and officials via the card dialer telephone network. This means that most questions on any aspect of a customer's business with the bank can be answered in less than a minute by calling the computer."

The Touch-Tone card dialer telephone sets used in the system are basically the same as those used by many businessmen who used the punched cards to dial frequently called phone numbers. In Beverly's system, however, there are eight Illinois Bell Data-Phone sets connecting the phones and the IBM computer. They translate the musical Touch-Tone signals into signals which the computer can accept.

Mr. Cooper said the system in practice works like this: "Each teller or other authorized bank official has an assigned code number punched on a small plastic card which is his key to the computer-stored information."

"By inserting this card in a slot in the Touch-Tone card dialer phone, the caller identifies himself as an authorized inquirer and gains access to the computer system."

"Similarly, each bank customer will have a card encoded with his account number. If a customer comes in, for instance, to cash a personal check, the teller inserts his own card to gain access and then inserts the customer card to identify the account about which he is inquiring."

"Finally, the teller taps out a code on the Touch-Tone push-buttons to indicate the specific information he is seeking."

"The computer, working from the coded instructions, looks up the required information in

the customer's files and then directs the audio response unit through the Data-Phone data sets and over the telephone to the teller. The entire transaction is recorded by the computer.

"The process is similar for savings transactions and loan and mortgage payments."

The 7770 audio response unit has a recorded vocabulary of 64 words and numbers with capacity for nearly twice that amount. The system is geared to handle up to 300 calls an hour.

Mr. Cooper emphasized that elaborate safeguards have been designed to protect customer records from unauthorized access.

"First of all," he said, "the telephone network is purely internal within the Beverly Bank and the client banks. No one from outside the banks can get into the network."

"And secondly, unauthorized access by bank employees and the various banks is prevented by the system."

"Besides the customer's signature, which we have always used as our primary security check, we have three security levels which the computer is programmed to check."

"First, each bank on the system is identified by code. Bank 'A' cannot have access to customer information of bank 'B'."

"Secondly, each teller or other authorized user is personally identified by code. There is naturally some information that a bank officer can obtain which a teller has no need for. If an employee makes an inquiry for information outside of his given field, the computer will simply respond to his call with the words, 'invalid inquiry.'

"And third, a customer's identification card also will have a security code, which will allow access to his records only. If he loses it, he can notify the bank, which will change his security code and render the lost card invalid."

The three outlying banks presently sharing the telephone/computer system are the Gary-Wheaton Bank, Wheaton; the Mount Greenwood Bank, 3052 West 111th Street; and the Riverdale Bank, in Riverdale. Plans call for a fourth bank, the Alsip Bank in Alsip—presently under construction—to be added to the system later this year, Cooper said.

The records of the various banks are stored in separate parts of an IBM 2314 direct access storage unit, which is capable of storing up to 200 million characters of information. Cooper points out that this is "like storing all the information in seven-and-a-half big Chicago telephone books."

### Computerized Clinic Scheduling

*Children's Hospital Medical Center  
Boston, Massachusetts 02115*

The Children's Hospital Medical Center announced in March that it has installed a computer to handle scheduling for its 54 outpatient clinics and to help return the "person-to-person touch" to patient care. The computer system was installed with a \$668,621 grant from the U.S. Public Health Service.

The Children's Hospital Medical Center maintains the 54 outpatient clinics in its newly completed \$4-million Fegan Memorial Outpatient Center. Approximately 40,000 children make a total of 150,000 visits to these clinics each year. That is 3,000 visits a week, better than 500 a day.

When the Fegan Center was completed, Children's used the grant to install a Honeywell Model 1200 computer system for a pilot study of computerized clinic scheduling. Previously this had been done manually. The federal grant covers a 3-year period. Children's plans several experiments to determine if computer

scheduling can substantially improve patient care and the clinics' service to the community.

"Our computer program may be the vehicle by which patients can be given the personal care they want and need," Dr. Leonard W. Cronkhite, Jr., General Director at Children's, said. "We believe it will let us give more comprehensive care in less time and at lower cost; but most important, perhaps it will help us reverse the trend of providing care in a cold, impersonal manner."

"We want to give each child visiting any of our clinics the same sort of individual care and direction he would receive from his private pediatrician," Dr. Cronkhite stressed.

Traditionally, outpatient clinics have operated on a first-come, first-served basis, with patients seeing whatever doctor happened to be free when their turns came up. In addition, because of the tremendous volume of patients us-

ing Children's clinics, a child needing to be seen in more than one clinic because of his combination of ailments usually had to make repeated return visits.

Children's clinic appointment system has been ineffectual, Dr. Cronkhite said, because there were so many patients and so many clinics. "We became mired in a paper swamp of futility and ineffectiveness, and ended up wasting both patient and staff time.

"The inefficiency has been costly, in terms of money to both the hospital and the patients' parents, and in terms of medical care because there has not been sufficient continuity."

The hospital hopes to solve these problems with its Honeywell Model 1200 computer system. Connected to it are 12 cathode ray television-like terminals installed in the reception area of the outpatient building and on each clinic floor.

With the computer, clinic personnel can almost instantly determine what appointment times are available in any of the 54 clinics, and can offer the patient or parent a choice of available times for appointments. Once a choice has been made, the appointment is put into the computer and held along with other patients' appointments for the same clinic or clinics on the same date. Several days before the appointment is due, the computer types out a complete listing of patients and their appointment times.

This listing, Dr. Cronkhite explained, goes to the medical records department which accumulates the patients' records and dispatches them to the proper clinic on the proper day.

Because the computer can store such a great amount of information, clinic personnel are now able to consolidate appointments for children who need to be seen in more than one clinic.

Prior to this time it was not unusual for a child and his parent to come to the hospital on one day for a visit to one clinic, return the following week for a session in another clinic, and then come back at least twice more for follow-up visits in the two clinics.

Through computer scheduling, appointments can be made in the two clinics for the same morning or afternoon, cutting in half the number of visits required to the hospital. The time and money saved for parent and child are considerable.

In the months ahead, as additional programs are written for the computer, clinic clerks will be able to schedule appointments with specific doctors for patients. Presently a patient may be handled by a different doctor at each visit. This not only extends the time needed for treatment, since the doctor must thoroughly familiarize himself with the patient's record, but the patient feels there is no personal contact.

"As much as possible in the future," Dr. Cronkhite said, "the patient will see the same doctor every time he comes to the clinic. This places the responsibility of care upon one physician's shoulders. The patient feels he belongs to this doctor, not to the institution. He gets a medical traffic cop to guide his care from one specialty clinic to another, and to maintain a personal management of the patient."

Children's will use the computer for studies in several areas of hospital management. One has to do with the high number of unkept clinic appointments. This runs from 20 to 40 percent at Children's clinics, compared to 3 to 5 percent in a private physician's office.

"We feel," Dr. Cronkhite explained, "that an analysis of data may explain why this happens. Perhaps there's something wrong in the clinic."

The computer also will have the ability to print out reminder cards to be mailed to parents a week or so before the scheduled visit. In addition it will be able to provide lists of children needing routine preventive care, such as vaccinations, at specific times, enabling the hospital to contact the parents with reminders.

"We have great expectations for this system," Dr. Cronkhite said. "We believe it will reduce costs both to the patient and to the hospital, will provide better staff utilization, permit continuity of care, reduce the number of visits required per medical episode, cut down patient waiting time, and help us have fewer no-shows at clinics."

"But of greatest importance, perhaps, as a result of all these advantages, we will be able to treat all patients with the privacy and dignity they deserve. We want to be able to say to every patient, rich or poor: 'Your child is getting the best medical treatment obtainable. You cannot buy better at any price.'"

The system consists of a central processor with a memory capacity of 65,536 characters, 12 cathode ray tube (CRT) terminals with input

keyboards, three teletype printers, one high-speed 650-line-per-minute printer, three on-line disk pack drives with memory capacities of 9.2 million characters each, four magnetic tape drives, an 800-card-per-minute card reader and a card punch.

The CRT devices are in various reception areas and administrative offices in the 11-story Fegan building. One of the teletype printers will be in the medical records library when it is completed (currently this printer is in the computer room). The other teletypes, run parallel in case one should breakdown, are in the main reception room. These are used to prepare hard copy material such as changes in patient identification.

The Fegan Building was designed with the child in mind. It has a main reception area on the street floor that guides the patient flow in and out of the building. In addition, each of the 11 floors has its reception area. These areas are as cheery, airy, and child-oriented as possible. There are comfortable chairs with cushions, not long wooden benches. Colors are bright and there are such things as blackboards for the children to scribble on.

The child's contact with the computer is limited, for the most part, to the CRT units. The CRT looks like his television set at home, except that it displays green writing instead of pictures. On one of the clinic floors, a clerk made the CRT even more familiar for the children by fashioning a paper flower and sticking it on top of the unit.

#### DATA KEPT UP TO DATE

The computer, with its great speed, keeps all the data a clerk needs for scheduling up to date, minute to minute. The CRT units make this information immediately available throughout the clinic building. Now, a clerk in the orthopedic clinic on the second floor does not need to waste time on a telephone contacting the surgical clinic on the third floor to see if an appointment can be made for a child. She merely presses a "command" button on the console of the CRT units for the next scheduled dates of the surgical clinic. The CRT, within seconds, displays the next 40 dates. The clerk selects the day convenient for the patient and the CRT displays all the unbooked time slots available in the surgical clinic that day. The clerk keys the patient's medical record number and the desired time slot and transmits this to the computer. And the appointment is made.

At the end of each clinic day, the computer is put to work on several housekeeping chores using the high-speed printer and magnetic tapes. First, it makes a printout of an alphabetical master log, listing all patients who have appointments on the next day. This is for the clerk at the main reception desk on the street floor. Second, the computer makes a printout especially for each clinic operating the next day. This contains the child's name in his proper appointment slot and any specific instructions for the doctor or nurse. Third, a list is prepared showing appointments two days in advance of the clinic. This list is used by the medical records library for pulling records. The records are shipped by conveyor belt to the proper floor.

#### TYPICAL OPERATION

When the child arrives at the clinic on the appointed day, the clerk at the main reception desk checks off his name against the master log and sends him to the proper floor. After the examination, subsequent appointments are scheduled on the clinic floor in the method described earlier.

A principal function of the computer as a scheduling tool is in maintaining an index file on patients who are actively using the clinic. This is a 200-character locator file containing the patient's medical record number, name, birth date, sex, religion, and such information as his financial category and appointment record.

A child's name gets into the computer in any one of several ways. One would be referral to the clinic by his doctor. The basic information is sent to the clinic from the doctor's office on a form. A clerk uses this data and the keyboard of the CRT unit to create the index record.

The CRT has an input keyboard with numeral and letter keys and a row of "command" function buttons. To begin an index record, the clerk presses a button marked "admit" and then types in all the data she has on the patient. This appears on the CRT as she types it. Next she presses the transmit button. The computer accepts the data and displays it back on the CRT, supplying a record number which now becomes a permanent part of the patient's file.

When the child and parent appear on clinic day and are able to be interviewed, the clerk presses the "inquiry" button and the proper record number. The child's file is displayed on the CRT with blanks where information may

be lacking. The clerk presses the "update" command button and fills in the blanks. Once the file is complete and the clerk has visually checked it for accuracy, she again presses the "transmit" button.

If there has been an error in entering the date, the computer will not accept the error line and will note at the bottom of the CRT: "error in line 2" so that a correction may be made.

Additional data on patients, primarily for accounting and billing, will be kept off-line on magnetic tape.

#### NINE ON-LINE FUNCTIONS

Children's will have nine on-line functions programmed for the CRT units. These are: admit, update, make an appointment, cancel an appointment, cancel a clinic session, inquiry, medical record request, attendance, and schedule change.

Each of the CRT units has direct access on-line to the computer. Children's controls what goes into the computer in several ways. For example, the function of the various CRT units is limited. An index record can be created only at the main reception desk. A change in medical records number can be made in the medical records library. Also any change to the basic information on the index record, number, name, age, sex, is automatically listed on the teletype printers.

So far Children's has written 38 batch programs for such things as reports and file maintenance and several subprograms for the nine command functions. All are in the Easycoder assembly language. Children's plans to keep

its index records on disk pack, figuring roughly 30,000 records per pack.

The input-output terminals are connected to the computer by cable. When the "transmit" button of the CRT unit is activated, the data goes into the central processor. If the computer already is doing a job, it goes into an interrupt, accepts the new data, stores it in the buffer zone, and then completes its current job. Then it takes the new job out of the buffer and does it. Normally there is a wait of several seconds between pressing the "transmit" button on the CRT keyboard and getting the completed job displayed back on the tube.

#### APPLICATIONS JUST BEGUN

The computer is newly installed and the applications have just begun. The principal objective is to make the mechanics of scheduling so quick and simple that a clinic can run on the same orderly, appointment system as the office of a private physician.

In the future, Children's plans to link its currently installed computer to another Honeywell Model 1200 computer system to be installed later this year. Together the computers will be designed to develop a total information system integrating all the hospital's medical, statistical, and financial data. Children's plans to have one computer handling on-line clinic scheduling and hospital bed control (Children's has 350 beds). The second machine, in addition to providing backup to the first, will process batch accounting, administrative, and statistical data.

The Model 1200 to be installed later this year will replace an existing IBM 360/30.

#### Accredited Computer Aided Course

*Florida State University  
Tallahassee, Florida*

Twenty-three Florida State University freshmen learned physics from a computer (see DCN, April 1968) during the fall quarter and made better grades than other students taking the same course in lecture classes.

Dr. Duncan Hansen, Director of Florida State's Computer-Assisted Instruction Center, said students in the experimental course, conducted under a U.S. Office of Education grant, "had an abnormally high scoring average in relation to lecture-room classes." He empha-

sized, however, that the CAI experiment was carefully controlled and that the effects on student performance are still being analyzed.

Dr. Hansen, in a report to the American Educational Research Association, said the CAI physics course has shown the power to produce effects in terms of conceptual understanding.

The physics project, believed to be the first accredited undergraduate college course fully taught by computer, was designed by Florida

State to examine student reaction and to measure the effectiveness of the computer against the lecture method of teaching.

The Florida State computer, an IBM 1500 instructional system, is programmed to teach a group of students individually, and at the pace each person desires to proceed. All students in the experimental physics class were required to complete 29 1-hour lessons, the same number given in classroom lectures.

The computer presented about 50 percent of the course material, and students obtained the rest from reference material and audio-visual aids assigned by the computer, along with homework.

Eleven of the 23 in the computer course received a grade of "A" for the quarter, virtually reversing the typical grading curve for a college course. Of the remaining 12, six had "B's" and six received "C's."

Dr. Walter Dick, associate director of the CAI Center, said the normal grading curve for 23 students in a lecture class would be three "A's," seven "B's," and 13 "C's."

Dr. Hansen said the experimental class students were volunteers and represented a cross-section of freshmen at Florida State. Thirty students enrolled for the course but seven dropped out because of scheduling conflicts.

"The students used and appreciated the flexibility of the course," he said. "The com-

puter allowed them to come and go as they pleased."

He said one of the students in the course played football. "He didn't come to the center regularly during the football season," Dr. Hansen said. "But, unlike missing a lecture class which cannot be made up, he worked overtime after the season ended and passed the course."

Dr. Hansen said teaching by computer apparently met an easy reception among freshmen. "All the students were very positive to the course," he said. "Students felt they had greater freedom, a greater opportunity to learn, and they felt they were learning more."

"And they made better grades, which was surprising to us. We didn't expect them to score better. They are no brighter than other students."

With some revisions, the physics course will be offered again in the spring quarter, with a greater number of students participating. "We shouldn't have any trouble getting volunteers," Dr. Dick said. "The word apparently has gotten out about the grades. We're getting calls every day from students asking about the course."

Dr. Hansen said the experiment also has stirred the interest of colleges and universities throughout the country.

"We're getting all kinds of requests for the CAI program," he said. "But it's not ready yet to put in a package and mail."

### GE Time Sharing for France

General Electric  
New York, New York 10022

General Electric extended its growing world-wide computer time-sharing service to the continent of Europe by announcing the first time-sharing center of its kind in Paris, France.

Bull-General Electric, GE's French computer affiliate, will put the advanced computer center into operation early in 1968, said J. Stanford Smith, Vice President and General Manager of GE's Information Systems Division.

"Anyone in Paris with a telephone can have instant access to a computer's problem-solving powers by next January," Mr. Smith stated.

The new French service will be built around the very successful GE time-sharing computer

already in wide use throughout the United States. Cost of the service varies with use, but can run under 1900 francs (\$400) a month including terminal and telephone line charges.

Service will be provided to Paris-area users initially, although Bull-General Electric is studying ways to expand the service to other areas in France in the future, Mr. Smith said.

De La Rue Bull Machines, Ltd., GE's computer marketing affiliate in England, introduced the first time-sharing computer service in Europe last August, when it inaugurated its center in London to serve customers throughout the United Kingdom.

"Our experience in England has demonstrated the great unsatisfied demand for this unique tool among businessmen, engineers, and scientists throughout Europe," Mr. Smith said. The Paris time-sharing center is a second step toward meeting this European demand, he emphasized.

Users of the Paris center will have the pick of a library of 250 computer application programs developed out of General Electric's experience in the United States, Mr. Smith pointed out. Language will not be a problem he said, since GE has developed a machine translator for turning its library programs into French.

General Electric time-sharing centers now serve every major metropolitan area in the United States and one center in Canada, making it the leading supplier of the service in the Western Hemisphere.

Until the advent of time-sharing, a man with a problem had to take it to a computer in a

complex programmed form and wait his turn for a solution.

Now each person has direct and immediate access to a computer whenever he needs it without leaving his office, home, or laboratory. Although many others may also be using the same computer, the system's response is so fast that each person has the "feel" of an entire machine to himself.

By "conversing" with the computer in a simple "language" learned within a few hours, computer laymen gain the answers they need without standing in line. Because of this rapid and direct dialog with the computer, new and different problems can be tackled by the machine, thus enlarging its usefulness beyond traditional applications.

As a result, the time-sharing computer has become a powerful tool in boosting the professional productivity of thousands of businessmen, engineers, scientists, students, and economists in their own fields of work.

### The Generation and Use of Reference Data

National Bureau of Standards  
Washington, D.C. 20234

To solve technical problems, scientists, engineers, and technologists require a great deal of technical information or data. Some data are specific to a problem, as the amount of water needed to supply a plant. Other data are not; for example, the density of water or the strengths of materials used in the supply tank. Data of the latter type refer either to intrinsic properties of matter or to uniformly controlled properties of commercial materials. As these data do not change from problem to problem, they can be used and re-used. Thus, it is desirable to collect them for ready reference.

Measurement of an intrinsic property of a pure material is usually thought of as a scientific measurement, while measurement of a technologically important property of a material or manufactured item is usually thought of as an engineering measurement. Although there is much overlap and no clearcut separation is possible, a qualitative distinction between scientific and engineering data is valuable because the two types of data are usually generated in different ways and appear in different places.

Scientific data are the results of experimental measurements and appear in the sci-

tific literature. In compiling scientific data for references, the initial selection process is a task of considerable magnitude. Usually, the publications of one of the various abstracting services are employed in the selection process. For an area of any scope at all, such compilation requires the selection of a few hundred individual reports for in-depth scanning from a field of several thousand. For major areas both the number of papers selected and the number available may be 10 times as large.

Additional scanning will probably show that only about half of the selected reports contain pertinent data. Because these data result from different experiments and different methods of approach, they contain variations caused by random fluctuation during the experiments and systematic differences caused by the different methods. To decide what value or average of values represents the closest approach to the inherent property desired requires a high level of knowledge of experimental methods and of the background of theory underlying the measurements, as well as sound judgment. It must be emphasized that critical evaluation of the data in an area is a task of sizable (and rapidly increasing) proportions which requires a high level of competence.

Engineering data are found in company and Government reports, technical sales literature, and specifications, as well as in technical journals. The methods of measurement tend to be highly specified and standardized. The standardization usually results from the deliberations of groups of experts acting under the sponsorship of some engineering society. Larger variations in structure and composition from sample to sample make intercomparison of data between samples less meaningful. Thus more emphasis must be placed on the design of the measurement method so that it will reflect a technically meaningful set of properties.

The need for technical competence in the compilation of both categories of data is recognized by the scientists and engineers, and a good job of critical evaluation is accepted as a technical contribution. Basically, compilation and evaluation are technical functions of a high order, and therefore are usually done as projects by workers carrying on a full spectrum of technical activities. There are few full-time data evaluators and they must keep in close contact with other types of scientific and technical work to maintain the competence which was a prerequisite for good critical evaluation in the first place. Thus, the evaluation of data is embedded in the matrix of technical activity and cannot generally be separated from it except on a project basis.

The utilization of reference data is at least as difficult to separate from the matrix of technical activity as their generation. Surveys\*,† have shown that chemists and physicists spend an average of one-third of their time on scientific communication—reading, writing, or talking about scientific matters. No other category of professional activity occupied as much of their time. Scientific communication did not include business communication which was a separate category in the surveys. It is probable that technical people in general spend more time on scientific communication than on any other single activity. From the nature of scientists' activities, the search for data evidently occupies an important, if unspecified, portion of this time.

\*An operations research study of the dissemination and use of recorded scientific information, by Operations Research Group, Case Institute of Technology, Report to Office of Scientific Information, National Science Foundation, Grant No. G-8434 (Dec. 1960).

†An operations research study of the scientific activity of chemists, by Operations Research Group, Case Institute of Technology (Nov. 1958).

The number of scientists, engineers, and technicians in the world is at an all-time high and is increasing rapidly. At the same time, the variety of types of problems being treated in a technical manner is also increasing so that there is a continued demand for technical personnel.

Science and technology are advancing rapidly, not only by expansion of their existing borders, but also by intensive investigation within these borders which results in a proliferation of fields. This increased technical activity produces an exponential growth of the technical and scientific literature, and hence of the data contained in it. Approximate figures for the years 1900 and 1950 and extrapolated figures for the year 2000 show this growth in terms of scientific journals and papers.‡

Date	Journals	Papers
1900	1,000	100,000
1950	3,000	300,000
2000	10,000	1,000,000

The rising need for critical evaluation cannot be attributed solely to increases in the number of technical personnel and volume of data. As more complex and sophisticated problems are attacked and as theoretical insight penetrates deeper, the standards of quality for acceptable data increase and the tolerance of uncertainty decreases. This increases the demands on the theoretical and statistical capabilities of evaluators. In addition, as data from widely divergent fields are used together, they must be convertible to a uniform basis in terms of definition. These data must also be consistent in the sense that no cumulative chains of error can occur during use which would lead to large errors in derived quantities. The increasing need involves quality as well as variety.

The value of standard reference data is very difficult to determine in terms of the actual investment of time in using such data, in search for it, or in evaluating data in the absence of standard reference data, although the need for and use of reference data is necessarily extensive. Some indirect indications of value are available, however, and certain direct benefits resulting from the use of standard reference data can be identified and, in some cases, evaluated quantitatively.

‡D. J. de Solla Price, "A Calculus of Science," Internat'l. Sci. Technol., No. 15, 37 (Mar. 1963).

Five categories of direct benefits which result from the availability of standard reference data are:

1. Saving of otherwise necessary search and evaluation costs.
2. Avoiding the cost of unknowingly duplicating previously completed experiments.
3. Minimizing overdesign.
4. Avoiding incorrect decisions based on incomplete knowledge of the existing data.
5. More accurate assessment of needs in allocating funds as a result of more accurate understanding of the range and quality of existing data.

The costs of experimental measurements are such that, except for rare cases when the sample material is already available and the apparatus set up, it is preferable to try to find data in the literature rather than to measure them again. As a result, the worker needing data is faced with roughly the same task as the compiler, and must make a literature search. Since the costs of doing this can be estimated, the first category is susceptible to quantitative evaluation.

An incomplete negative search can lead to an unknowing, unnecessary duplication of effort. (It might also be noted that there is no clearcut measure of completeness.) That such duplications occur is well known but difficult to document since there is no natural source for publishing such experiences.

In any design, safety factors are introduced to allow for lack of adequate knowledge. By their nature these safety factors add to the cost of the item being designed, so that the cost can be reduced as more reliance can be put on the data used in the designs. Again, examples of overdesign resulting from inadequate knowledge of the data are not publicized. Incorrect decisions based on incomplete data are not generally publicized either.

Although the fifth category is difficult to evaluate quantitatively, its importance in an era of increasing competition for funds is obvious. It should be noted that the evaluation process, which involves a complete evaluation of all possible experimental sources of variability, provides a set of standards for measurements of the highest reliability. This set of standards can then be used by experimental workers to ensure that their measurements are properly controlled and properly reported. Thus the process of critical evaluation acts not only to indicate gaps in the literature but also to set standards for future measurements.

### Computer Dispatching of Police Cars

New York City Police Department  
New York, New York

New York City has awarded a \$4.7-million contract to International Business Machines Corporation for the development of a computer-based system that will dispatch police cars to scenes of emergencies seconds after they are reported.

Named SPRINT—Special Police Radio Inquiry Network—by the Police Department, the new system will cut response time to calls for police assistance to a minimum.

When the new network is fully installed, in 1969, all emergency calls will be handled through a central police communications bureau. Now, calls are routed to bureaus in each of the five boroughs.

At the central bureau, police officers will man special display terminals equipped with TV-like screens and keyboards and connected by communications lines to an IBM System/360 Model 40.

A call for police assistance will be handled like this:

The officer receiving the call presses keys on his terminal to identify the borough, location and type of incident. After checking a display of this data on his screen, he transmits it to the computer by touching another key.

The computer checks the data and informs the officer of errors, such as a non-existent address, by flashing a message on the terminal screen. It then searches an electronic location file and determines the block number, precinct, nearest intersection, and nearest hospital.

This information, along with the numbers of three available patrol cars, is flashed to the appropriate one of several additional terminals manned by radio dispatchers, each of whom covers a specific area of the city. The dispatcher then orders a car to the scene, inform-

ing the computer of his action through his keyboard.

The computer will maintain a continuous electronic "inventory" of the availability of cars on the streets. In critical situations, such as those involving many calls, or if the number of available cars falls below a certain point, the

computer will alert bureau personnel by flashing messages on terminal screens.

With SPRINT, police officers throughout the city will also be able to radio in vehicle license numbers for immediate checking against the computer's file of stolen vehicles.

### "Hidden Line Problem" in Computer Graphics

New York University  
New York, New York 10003

The knotty "hidden line problem" in computer graphics has been solved with "elegance" by a graduate student in electrical engineering at the New York University School of Engineering and Science.

The problem is that of programming a computer to generate perspective drawings of three-dimensional objects and then identify and, if desired, eliminate any edges not visible from a specified vantage point. The solution is an efficient procedure that enables a computer in just seconds to generate line drawings of any polyhedron (any solid object with straight-line edges and flat faces) with the "hidden lines" either deleted or shown by dashes.

Phillipe Loutrel, a Ph.D. candidate from Paris, achieved what his faculty adviser describes as an "elegant, efficient solution" in work for his doctoral dissertation. The adviser, Prof. Herbert Freeman, said it is a "major improvement" over earlier procedures that relied more on "brute force."

"I don't expect much improvement on Mr. Loutrel's technique for some time to come," he said.

Architects, engineers, and designers of all types make extensive use of computer graphics to visualize, alter, and manipulate perspectives of real or proposed 3-D objects. A drawback until Loutrel's development, however, has been that the drawings are cluttered and confused by lines representing "hidden" back edges that should not be seen.

The mathematics involved in developing efficient procedures for directing a computer to calculate and eliminate hidden lines has been a formidable obstacle. Earlier solutions required

several minutes of computer calculation, making them expensive and of little use with fast, on-line cathode ray tube display equipment.

Mr. Loutrel cut the calculation time from minutes to seconds by devising techniques that classify and immediately eliminate most of the totally invisible edges and then minimize the testing necessary to identify the remaining hidden edges. The technique may be fast enough to make possible the elimination of hidden lines in drawings of 3-D objects displayed in continuous or near-continuous motion on cathode ray tubes.

Mr. Loutrel also extended his technique to handle complex illumination problems. With information on the location of the light source and observation point in relation to a 3-D object, it enables computers to calculate what lighted faces of the object would be visible to the observer.

The technique gives designers and architects the ability to produce, in seconds, realistic line drawings of objects such as buildings without the confusion of unwanted lines. By means of simple computer instructions, operators can alter the drawings, look at them from any angle, and study them under the effect of lighting from any angle.

Mr. Loutrel, who has returned to France, received his Ph.D. in electrical engineering in February. He received a masters degree in the same field from NYU in 1964 and was graduated from the Ecole Supérieure d'Electricité in Paris in 1963. His research, sponsored by the National Aeronautics and Space Administration, is described in the NYU School of Engineering and Science Technical Report 400-167.

## On-Line Electrocardiograms

*University of Southern California  
Los Angeles, California 90007*

For the first time, the University of California's School of Medicine is using an on-line computer to perform continuous monitoring of the electrocardiograms of patients in a coronary care unit.

According to Dr. L. Julian Haywood, associate professor of medicine and director of the unit located at Los Angeles County General Hospital, the high-speed computer is programmed to monitor ECG recordings of patients in the four-bed coronary care center for possible disturbances in heart rhythms which would require prompt action by medical personnel.

"The computer is not responsible for making decisions about patient care," Dr. Haywood said. "It does, however, serve as a reliable method for rapid detection of arrhythmias."

The USC cardiologist said use of the computer will supplement the present system of surveillance provided by oscilloscopes mounted at each bedside. Sensing devices taped to the patient's body record the electrical impulses of the heart on these bedside units, as well as on four oscilloscopes at the nurses' station centrally located in the unit, and on a four-patient control unit in an adjacent doctor's room.

A single electrocardiogram lead from each patient is fed to the computer. Initially, the computer scans the ECG for a repetitive sequence of electrical activity preceding the active beating of the heart. From this wave form, reference points are found which the computer times, measures, and converts to numerical values. Thereafter, each component wave in the cycle is similarly measured and recorded and parameters determined for continuous comparison.

Monitoring consists of comparing each consecutive sequence to previous cycle averages. If the signal from the ECG changes, the computer is programmed to recognize the occurrence of change and to begin immediately to record and study the new signal. If the signal exceeds established maximum or minimum values, the computer will sound an alarm. The system can relieve the nurse from continuous observation of the oscilloscopes, so that she is free to carry out her other duties, Dr. Haywood noted.

"The obvious value of a computer evaluation is the rapidity with which information can be made available," he said. "The computer can describe any distinctive change in any of the components of an individual cycle, and it scans the ECG on all four patients simultaneously. Improved patient care is implicit in this monitoring system, since the greatest single determinant of survival following an acute heart attack is the detection of potentially dangerous rhythm variances which require prompt active or preventive therapy," the USC cardiologist added.

The computer's accuracy can be checked by calling for simultaneous print-outs of the numbers it has established for all components and for the ECG tracing, and then comparing the two. The Control Data Corporation Model 1700 digital computer, which has a 16,000 word core memory, can also provide a table of numbers describing each ECG, a curve plot of the distribution of the numbers, and a record of the original cycle.

The County Hospital-USC coronary care unit was established a year ago, under grants from the U.S. Public Health Service and the Los Angeles County Heart Association. It has become a center for training nurses and physicians in the use of specialized equipment, and in routine and emergency procedures authorized for the care of patients with heart diseases. Over 60 nurses from approximately 25 hospitals have completed the course and a total of 212 patients with heart disorders have been treated in the four-bed unit during the past year.